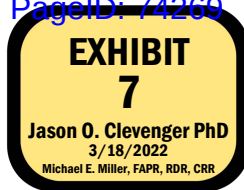


# **EXHIBIT A**



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**Abstract** | A snapshot of the sale of fentanyl and its analogues across several popular darknet markets between 2 January and 27 March 2019 reveals the amount, types and physical forms available.

Of the 127,541 unique drug listings identified, 13,135 were opioids (10.3% of all drugs), of which 1,118 (0.876% of all drugs) were fentanyl or its analogues. Between 27.3 and 39.3 kilograms of fentanyl and its derivatives were available over the period.

The average price of fentanyl was A\$99 per gram, while carfentanil was A\$26.8 per gram.

The shipping methods, cross-market operations and product specialisation of the 303 active fentanyl vendors on these darknet markets are also described.

## Fentanyl availability on darknet markets

Roderic Broadhurst, Matthew Ball and Harshit Trivedi

### Introduction

The convergence of anonymous online illicit darknet markets (or cryptomarkets) and cryptocurrencies such as Bitcoin has created an efficient retail platform for illicit markets, including potent new synthetic opioids such as fentanyl. As only small quantities of these new drugs are needed to pass border and customs barriers, a revolution in the distribution of illicit drugs is occurring.

The United Nations illicit drug user surveys and police seizures also suggest drug usage, especially of amphetamine-type stimulants, synthetic opioids and other new psychoactive substances (NPS) is on the rise (United Nations 2018). Illicit drugs, including fentanyl and its analogues, are widely available via darknet e-commerce markets, and online vendors use postal services to distribute small quantities of fentanyl and other highly potent synthetic opioids (Pardo et al. 2019: 70). A mere 16.8 milligrams of fentanyl extracted from a 100-microgram transdermal patch purchased on the street in Australia (valued at between A\$75 and A\$450 per patch) could produce 5.5 grams of heroin equivalent, valued at between A\$1,100 and A\$3,850. Ten grams of fentanyl purchased on the darknet for A\$1,000 could produce the equivalent of one kilogram of synthetic heroin, valued at between A\$160,000 and A\$195,000 in the domestic illicit market, making the Australian drug market among the most expensive in the world (Australian Criminal Intelligence Commission 2019).



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A substantial share of internet traffic in the encrypted 'deep web' accesses darknet markets such as Berlusconi or Dream, which specialise in the sale and distribution of contraband (Al-Nabki et al. 2019; Moore & Rid 2016). Typical products offered include illicit drugs, pharmaceuticals, fraudulent identity documents, malware and hacking kits, counterfeit goods and weapons. Europol estimates that two-thirds of the products listed on darknet markets between 2011 and 2015 were drug related and that these markets are 'one of the engines of organised crime' in Europe (European Monitoring Centre for Drugs and Drug Addiction (EMCDDA) & Europol 2017: 15).

Search engines such as Google and Bing cannot access the darknet. Darknet markets are commonly accessed via 'Tor', which operates an overlay network of anonymous servers (onion routers), masking the original IP address of the user. Anonymity is further ensured by the use of cryptocurrencies such as Bitcoin or Monero for electronic payments (Saleh, Qadir & Ilyas 2018). Darknet markets are vulnerable to distributed denial-of-service attacks, exit scams (where a business stops completing orders but continues to accept payment for new orders), voluntary closures, and occasionally hacks, de-anonymisation, or seizure by law enforcement (EMCDDA & Europol 2017: 8). Markets are typically short lived, with many operating for less than 12 months (EMCDDA & Europol 2017: 16), but others such as Dream Market and Tochka (both included in this study) have operated since 2013 and 2015 respectively.

Darknet markets mimic conventional e-commerce services, having three main actors: vendors, buyers and market administrators. Buyers can leave reviews, send messages to vendors and dispute transactions. Vendors give product descriptions and basic details such as quantities, prices and shipping services. Administrators typically receive a commission of between three and eight percent from each sale and provide escrow services and overall supervision of the website and market operation (Broadhurst et al. 2018). For example, we observed that Dream charged a US\$300 (A\$420) vendor bond, received a four percent commission on sales, and required payments in Bitcoin or other cryptocurrencies via an escrow service.

Fentanyl has entered illicit drug markets worldwide, leading to an opioid epidemic in North America (National Institute on Drug Abuse 2019). Fentanyl is easy to modify, which has led to the production of many derivatives, such as the highly potent 3-methylfentanyl and carfentanil (Schueler 2017). The potency of different opioids is measured relative to morphine's effectiveness as a pain suppressant. Fentanyl is reported to be 50 to 100 times stronger than morphine, depending on user tolerance and purity. The derivative **carfentanil**, the active ingredient in Wildnil (a tranquilliser approved for veterinary use) is distinguished by its **extraordinary potency and is estimated to be at least 10,000 times stronger than morphine**. A fatal dose of fentanyl can be as little as two milligrams—the equivalent of four grains of salt—but a **fatal dose of carfentanil is invisible to the naked eye**. Carfentanil is cheaper than heroin and about 1/3300th the bulk of a dose-equivalent weight of heroin. A **dose of 20 micrograms (ie 0.02 milligrams) is likely fatal** (Schueler 2017; World Health Organization 2017). Fatalities have also been caused by the consumption of counterfeit pharmaceutical pills containing fentanyl, as well as fentanyl-laced heroin, cocaine and other NPS (eg U-47700; World Health Organization 2017).

Darknet markets enable a global trade in fentanyl from various sources, including diversion from pharmaceutical manufacture, clandestine production and prescription medication. The presence of fentanyl on darknet markets makes it relatively easy to acquire in a variety of physical forms. Fentanyl's potency allows it to be shipped in significantly smaller quantities than other opioids. This makes it attractive to vendors, who specialise in stealth packaging and use commercial postal and courier services. The massive volume of mail now generated by e-commerce offers camouflage for suspicious contraband and overwhelms postal inspection services (Australian Criminal Intelligence Commission 2019). These factors make it difficult to regulate the manufacture and distribution of fentanyl (O'Connor 2018).

## The synthetic opioid revolution

The efficiency and anonymity of the illicit digital economy has combined with a well-organised and lucrative trans-Pacific contraband trade with global reach. Precursor chemicals for amphetamine-type stimulants, opioids and NPS are diverted or clandestinely manufactured in China and India, and shipped into North America via Mexico. Chinese and South American crime groups dominate the supply of these illicit products and have adapted to the opportunities offered by darknet markets (Broséus et al. 2017). The impact of cheaper 'China White' (heroin laced with fentanyl) on the large North American heroin supply chain has increased the risk of overdose deaths and simultaneously reduced the value of opium production in Mexico (Le Cour Grandmaison, Morris & Smith 2019). Consequently, transnational organised crime groups facilitate the global supply of cheaper synthetic opioids to meet the demand for pain relief and escapism (Broadhurst 2017; Hamilton 2016).

The scale of this illicit market can be gauged by recent seizures. In January 2019, 115 kilograms of fentanyl estimated to be worth US\$3.5m (A\$4.9m), or about US\$30,500 (A\$42,700) per kilogram, was seized at the US–Mexico border (Schwartz 2019). In August 2019 a massive 23,368-kilogram shipment of fentanyl originating in Shanghai and destined for the Sinaloa crime cartel was seized by Mexican customs and naval authorities at the port of Lázaro Cárdenas (Morgan 2019). Clandestine synthetic opioid laboratories operating in Mexico have also been found, suggesting that the importation of fentanyl precursors and the local production of fentanyl are an emerging trend (Le Cour Grandmaison, Morris & Smith 2019).

The United States Drug Enforcement Administration explained the attraction of these synthetics over traditional opioids, and especially the substitution or adulteration of heroin with fentanyl, in a guide for first responders:

...criminal organizations can use one kilogram of fentanyl to produce approximately 1 million (1 milligram) counterfeit pills, resulting in potentially 10-20 million dollars in revenue.

There are also reports that consumers in some areas are seeking fentanyl over heroin, as the "rush" is greater. (US Drug Enforcement Administration 2017: 7)

Ciccarone, Ondocsin and Mars (2017: 152) noted a range of views among a sample of 38 heroin users, including concerns about fentanyl's overdose risk and short duration but also the 'rush' and its 'potency in overcoming their heroin tolerance'. They reported that some users believed the heroin–fentanyl mix was 'the ideal opioid with the fentanyl providing intensity and the heroin a longer lasting effect for the "best of both worlds"'. Drugs as diverse as cocaine, Xanax and MDMA are also testing positive to fentanyl, although reports on the purity of opioids and other illicit drugs sold on darknet markets are limited (National Institute on Drug Abuse 2019; Quintana et al. 2017).

In the United States overdose deaths from prescription opioids have quadrupled since 1999 (Volkow & Collins 2017). Of the estimated 70,237 overdose deaths in 2017, 47,600 were synthetic opioid related (Centers for Disease Control and Prevention 2019; Hedegaard, Miniño & Warner 2018). The increase in overdose deaths in the United States has been attributed to the widespread use of prescription opioids for chronic pain management—and an increase in opioid prescriptions has also been observed in Australia (Brown & Morgan 2019). The Australian Bureau of Statistics (2017) reports drug-induced deaths have been increasing since 2011, with 1,808 recorded deaths in 2016 and prescription drugs causing the highest number. Such a high rate of drug-induced fatalities has not been recorded since the heroin epidemic of the late 1990s.

However, there is little evidence of widespread misuse of fentanyl in Australia, either among police detainees (Sullivan & Patterson 2018) or those using heroin at the Sydney injecting centre (Barratt et al. 2018). Australia may be at the start of an opioid epidemic driven by access to synthetic opioids including fentanyl both on the street and online (Rodda et al. 2017) but has the advantage of being able to adapt supply, demand and harm reduction policies and practices (Brown & Morgan 2019).

### The role of the darknet in drug supply

The National Drug and Alcohol Research Centre monitored drug trends on darknet markets between July and December 2016 and found that AlphaBay (closed by law enforcement in May 2017) and Dream Market were the largest darknet markets and the most widely available drugs were cannabis, pharmaceuticals, MDMA, cocaine, methamphetamine and NPS (Roxburgh et al. 2017). The same study noted the growing presence of the opioid analgesic analogues U-47700 and furanylfentanyl and the need to monitor the emergence of opioid analogues on darknet markets, given seizures of carfentanil and furanylfentanyl at the Australian border (Roxburgh et al. 2017).

In October 2015, China designated the previously unregulated NPS alpha-PVP ('flakka') as a controlled substance and placed restrictions on its export, along with another 115 chemicals used to make synthetic drugs without any legitimate medical or other use (O'Connor 2017). In March 2017 China introduced further regulation of NPS—notably fentanyl and the more potent carfentanil—following alarming increases in deaths caused by these opioids (O'Connor 2018). In May 2019 further restrictions were placed on the manufacture of fentanyl and its precursors (NPP and 4-ANPP) including criminal penalties and, in September 2019, oxycodone was listed as a psychotropic, restricting its production and prescription (Reuters 2019). Prior to these regulations several laboratories in China were reportedly selling carfentanil for US\$2,750 per kilogram; the drug was also available on the darknet for between US\$800 and US\$2,500 per gram (Misailidi et al. 2018). An unintended effect of regulatory enforcement in China has been the displacement of production to less regulated states (Broadhurst 2017).

Australians are active on darknet markets. Interviews conducted as part of the Australian Ecstasy and Related Drugs Reporting System included questions about online purchases from a darknet market. In 2017, 22 percent of psychostimulant users surveyed had purchased an illicit drug online in their lifetime, with 16 percent reporting they had done so in the past 12 months (Uporova et al. 2018). This was an increase from 18 percent (14% in the past year) in 2016 and 14 percent (10% in the past year) in 2015 (Stafford & Breen 2016; Uporova et al. 2018). The vast majority of those surveyed in 2017 (93% compared to 85% in 2016) reported having knowledge of these markets (Uporova et al. 2018).

## Aim

This paper estimates the availability of fentanyl and other synthetic opioids on a sample of general or omnibus Tor darknet markets between 2 January and 27 March 2019. It extends the description of fentanyl availability previously reported for 2 January to 23 February (Ball, Broadhurst & Trivedi 2019).

## Method

Data were collected from several Tor websites with a focus on fentanyl products. Data were collected over 84 days (from 2 January to 27 March 2019) from 64 'scrapes' of six omnibus darknet markets: Berlusconi, Dream Market, Empire, Tochka, Valhalla ('Silkkitie') and Wall Street. Each of these markets posted at least 1,000 products across different contraband categories. We report only unique products listed daily by each vendor, excluding repeat listings of the same product where this occurs on each market. The relevant ethical protocol (Australian National University: 2019/498) for this study required that we not conceal our data collection. We provided the means for market operators to contact us via the agent string identifier found on standard crawlers, but none has done so.

Given that the number of darknet markets operating in Tor is unknown and estimates of hidden criminal services vary, the selected darknet markets may not be representative of darknet markets as a whole. Al-Nabki et al. (2019: 217) identified 20 percent of 10,367 known Tor sites as 'suspicious' or criminal and 48 percent as 'normal' (hosting and cryptocurrency services), while 32 percent were classified as unknown because they were unavailable, empty or locked. Defunct sources such as the online darknet 'information centre' Deep Dot Web (see Ladegaard 2019) listed 40 to 50 markets as being active in early 2019, of which a dozen were omnibus (Gilbert & Dasgupta 2017: 162).

All markets except Berlusconi experienced some downtime over the data collection period. Valhalla ceased operations in February when its operators were arrested (Europol 2019). Dream Market was subject to sustained distributed denial-of-service attacks from mid-February to mid-March, first temporarily suspending services and then opting for a 'soft exit' from 27 March 2019 (ie an orderly closure rather than an 'exit scam', where market operators steal escrowed funds). Dream Market banned the sale of fentanyl in June 2018 but was included in this study because it was the largest market identified and because fentanyl and other 'forbidden products and services' may still be listed occasionally (eg assassinations, weapons, poisons, child pornography and videos of people being hurt or murdered).

Data was captured from websites using 'crawler' and 'scraper' technologies commonly used in the open net and widely used since the 1990s. These tools are designed to automate the data capture and extraction process. A crawler is an automated script designed to search an entire website in a methodical manner and find as many unique pages as possible. This crawling process creates a static copy of the websites for later analysis. These copies record the time at which the data was captured, as well as retaining the structure of the page, allowing researchers to navigate the static site as if browsing in real time (Christin 2013). This is crucial in the case of volatile darknet markets. A scraper extracts or 'scrapes' data from HTML pages. This data is exported to a comma-separated value file that statistical programs (eg Stata, SPSS) can import and use for analysis.



Web crawlers designed to function in Tor capture details of products, prices and vendors. They also circumvent defences designed to prevent distributed denial-of-service attacks, a common way to disrupt a market competitor. Most darknet markets use 'CAPTCHA' logins (Completely Automated Public Turing test to tell Computers and Humans Apart) that restrict botnet and automated browser activity and limit the number of webpages or product listings a visitor may access in a single session.

Analysis of the products available on darknet markets was limited to those the vendors claimed were fentanyl, and the availability of this and other synthetic opioids on these markets is therefore likely to be under-reported. Only products labelled as fentanyl or its derivatives were included in this analysis. Products listed under colloquial names (eg 'Apache', 'China White', 'Bear', 'TNT'), whose potency and chemical composition are unknown, are excluded, although we note their presence and that of the fentanyl-like NPS U-47700 and its derivatives. In this study we focus on availability and do not estimate the weight sold drawing on customer reviews or the number of transactions listed by vendors or markets (eg Kruithof et al. 2016). Not all darknets show reviews or sales tallies, and repeated daily observations suggest vendors and market operators are probably gaming these systems. Further details of the data capture methods, limitations and estimates of weights and prices are provided in a technical report (Ball, Broadhurst, Niven & Trivedi 2019).

## Results

Table 1 describes the number of products (broadly classified) available over the first three months of 2019. Almost half the products listed (49%) were drugs, of which ten percent (10.3%) were opioids. Fentanyl accounted for over eight percent (8.5%) of the opioids listed. Dream Market accounted for the majority of products, drugs and opioids available, although most of the fentanyl available was found on Wall Street. Two weeks after the end of data collection, on 12 April 2019, Wall Street was disabled and its operators arrested as a result of a joint US–Europol criminal investigation (Europol 2019).

An earlier snapshot (Ball, Broadhurst & Trivedi 2019) based on 36 'scrapes' or daily observations (2 January–23 February 2019) identified 439 fentanyl products (0.347% of all drugs). With 28 additional daily observations, 1,118 fentanyl listings were identified (0.876% of all drugs).

Table 1 shows that well-known darknet markets are an avenue for distributing synthetic opioids such as fentanyl and other high-value, low-mass NPS. The number of listings is insignificant compared with those of other drugs such as cannabis, cocaine and amphetamine-type stimulants, but the potency of fentanyl amplifies the likely impact.

**Table 1: Market share by all unique products, drugs, opioids and fentanyl listings**

Market	Unique listings <i>n</i> (%)	Drugs <i>n</i> (%)	Opioids <i>n</i> (%)	Fentanyl <i>n</i> (%)
Berlusconi	47,351 (18.25)	15,649 (12.27)	412 (3.14)	87 (7.78)
Dream	167,079 (64.41)	89,753 (70.37)	8,572 (65.26)	48 (4.29)
Empire	10,394 (4.01)	3,217 (2.52)	205 (1.56)	36 (3.22)
Tochka	4,400 (1.69)	2,208 (1.73)	518 (3.94)	48 (4.29)
Valhalla	10,765 (4.15)	7,110 (5.57)	262 (1.99)	45 (4.03)
Wall Street	19,403 (7.48)	9,604 (7.53)	3,166 (24.10)	854 (76.39)
Total	259,392	127,541	13,135	1,118

Note: 'Unique Listings', 'Drugs' and 'Opioids' are based on the listings found on all markets (2 January to 27 March 2019). Percentages refer to column totals. Percentages may not total 100 due to rounding. Valhalla ceased on 13 February 2019, Dream Market ceased on 26 March 2019, and Wall Street ceased on 12 April 2019

## Products, prices and weights

Over three-quarters of the available fentanyl products were listed on Wall Street ( $n=854$ , 76%), followed by Berlusconi ( $n=87$ , 8%). Despite Dream Market's ban on fentanyl sales, 48 listings (4%) were found, equal to the number of listings found on Tochka, followed by Valhalla ( $n=45$ , 4%) and, finally, Empire ( $n=36$ , 3%).

Over the observation period, at least 27.31 kilograms of fentanyl products were available to buyers. For one in four fentanyl products listed ( $n=282$ , 25%), vendors did not provide weight values or the number of tablets or patches. Adjusting for these missing values by using the mean weight of known listings as proxy values leads to an upper estimate of 39.3 kilograms. This is likely an underestimate because, as noted, only products labelled as fentanyl were included. For example, 290 products with a total weight of approximately 7.76 kilograms were listed under the colloquial name 'China White' and were probably laced with fentanyl. In addition, 25 proprietary prescription fentanyl products were identified, including 18 Sandoz, five Duragesic and two Actiq lozenges with a total weight of 0.318 grams. Two of these products were listed on Dream Market. Ten kilograms of U-47700 (and derivatives) were also estimated to be available across the six markets.

Of the 13,135 opioids listed, 846 (6.44%) were partial opioid agonists. The presence of opioid agonists such as methadone ( $n=492$ , 3.74%), buprenorphine ( $n=288$ , 2.19%) and naloxone ( $n=72$ , 0.55%) suggests there is user demand for harm reduction and self-medicated recovery.

Table 2 shows the number of unique listings of different opioids, the estimated average price per gram and the lower estimates of the available quantities in kilograms. Heroin and oxycodone accounted for half all the opioids listed, followed by tramadol, fentanyl, codeine and morphine. Opium and the partial opioid agonists methadone and buprenorphine are also listed on most markets. Based on the estimated overall weight, oxycodone accounts for eight percent of all opioids, indicating numerous listings of smaller quantities, whereas tramadol (18%) and fentanyl (15%) account for a larger share of the available opioids.



**Table 2: Opioids available on darknet markets, by type of opioid**

	Unique listings	Market share: % of listings	Weight in kilograms	Market share: % weight	Average price per gram (A\$)
Heroin	4,839	36.25	69.76	37.5	115.06
Oxycodone	3,169	23.74	14.41	7.76	1,931.77
Tramadol	1,525	11.42	32.58	17.54	459.62
Fentanyl <sup>a</sup>	1,118	9.95	27.31	14.70	91.92
Codeine	827	6.20	25.95	13.97	277.57
Morphine	591	4.43	6.52	3.51	518.90
Methadone	492	3.69	6.80	3.66	839.12
Opium	290	2.17	1.64	0.88	48.95
Buprenorphine	288	2.16	0.79	0.42	4,057.56

a: Includes all fentanyl analogues

Note: Weight values are all lower estimates (unweighted for missing values)

The average price of fentanyl was calculated excluding extreme outliers (eg vendors offering free samples or charging extremely high prices for 'pure' product). Vendors typically sell fentanyl in small quantities—micrograms or milligrams—but offerings in grams and occasionally kilograms are also observed. Table 3 compares the physical forms, the average price per gram and overall quantities found in the six markets. For comparison, the street price in New South Wales of a 100-microgram patch of fentanyl is estimated to range from A\$75 to A\$450, with the average darknet price occurring at the lower end of this range, noting that street prices vary by location (Australian Criminal Intelligence Commission 2019). Fentanyl patches or powder were priced at an average of A\$99 per gram across the six markets, with more potent derivatives averaging lower prices of A\$20.50 to A\$26.80.

Average prices across vendors and markets were volatile during the observation period. The price of fentanyl increased from A\$79 to A\$99 per gram between January and March 2019. Average prices for fentanyl analogues generally declined since those for February 2019 were reported by Ball, Broadburst and Trivedi (2019); for example, the price of carfentanil was estimated to be A\$300 per gram but was less than 10 percent of this price (A\$26.8) by the end of March 2019. This dramatic change is attributed to the subsequent increase in available stock, especially on Wall Street, and the common vendor practice of significantly raising prices when supply is low. We removed these extreme outliers for the estimates reported in Table 3.

Of the 1,118 fentanyl products in the dataset, 507 did not describe the physical form. The remaining 611 came in the form of pills, patches, powder, solutions, blotters and sprays. Patches and powder accounted for about 88 percent of the physical forms after adjusting for missing values.

**Table 3: Total estimated weight and unit prices of fentanyl and analogues**

	Potency relative to morphine <sup>a</sup>	Weight (kilograms)	Market share (%)	Average price per gram (A\$)	Common physical forms
Fentanyl	80 – 100×	12.63	46.24	98.97	powder, patches
Carfentanil	10,000 – 100,000×	8.05	29.49	26.79	powder, solution
Furanylfentanyl	20×	4.01	14.67	55.15	powder
Methylfuranylfentanyl	400 – 500×	2.16	7.93	20.50	powder
Methoxyacetylfentanyl	50 – 100×	0.44	1.61	8.47	powder
Methoxyacetylfentanyl	50 – 100×	0.44	1.61	8.47	powder

a: National Institute on Drug Abuse 2019; Schueler 2017

## Vendors

We identified 9,713 unique vendors (determined by the 'handle', path-name or PGP key) across the six darknet markets surveyed. Among these, 303 vendors (3%) were identified as selling fentanyl, but only nine of these operated in multiple markets. On average, each vendor offered 86.98 grams of fentanyl, with half (the median) offering less than 35.15 grams. Twelve vendors (4%) offered at least 1,000 grams each, and accounted for 80 percent of all the available fentanyl. Among fentanyl vendors, 98 (32%) offered worldwide shipping (including to Australia), but another 113 vendors (37%) did not provide details about shipping services. Another 88 vendors (29%) were banned from selling on one of these markets during the course of our study. They may have been removed for selling banned products or scamming their customers.

Over a third ( $n=114$ , 38%) of vendors sold carfentanil and 11 (4%) sold methylfuranylfentanyl, both of which are more potent than fentanyl. From the data available, it is possible that several Australian-based fentanyl vendors are operating in these markets. Most vendors appear to be generalists, listing many types of drugs. However, several vendors specialise in fentanyl and carfentanil, often selling significantly larger quantities of these drugs.

## Discussion

These findings suggest that fentanyl may have growing significance in darknet markets. Broséus et al. (2017) analysed the Evolution darknet market between 2014 and 2015 and identified 92,980 products and 4,171 vendors, reporting that 63 percent of listings were illicit drugs (cannabis was the most commonly available) and opioids accounted for four percent of all drug listings. Of the 4,500 opioid products (9% of all drugs) for sale on Dream Market in September 2017, 10 percent comprised fentanyl, 29 percent heroin, 16 percent oxycodone, seven percent morphine, seven percent opium, five percent codeine, and five percent buprenorphine (Broadhurst & Lord 2017).

Monitoring the evolution of darknet markets is required to understand how they shape trends in recreational and dependent drug use. Overdose spikes resulting from specific sources may go unnoticed without the appropriate medical and policing response (Roxburgh et al. 2017). A better understanding of the business models, tradecraft and criminal networks involved could assist in targeting vendors and informing cross-border law enforcement strategies. The ascent of a 'gentrified' retail model of drug trade and its harm reduction potential also warrants attention. Martin (2017) notes that the upsides of darknet drug markets include product purity, information about safer options and fewer threats of violence (see also Barratt, Ferris & Winstock 2016).

Despite the limited scale and duration of this data collection, a small but significant fentanyl market was identified on the darknet, including unexpected quantities of carfentanil (30% of all fentanyl products). A fatal dose of fentanyl is two milligrams, while a usual dose is 0.2 milligrams (200 micrograms). So the lower estimate of 27.31 kilograms corresponds to 9.558 million lethal doses or 95.588 million typical doses of fentanyl. Adjusting for carfentanil's higher potency (0.02 milligrams is likely fatal, and 0.002 milligrams or 2 micrograms is sufficient to induce a heroin-like effect), we estimate 409.665 million fatal doses and perhaps 4.096 billion typical doses were available. Such highly potent drugs have the potential to be weaponised by crime groups and violent extremists.

Almost one-third (30%) of the estimated 27.3 to 39.3 kilograms of fentanyl products for sale were the extremely potent carfentanil analogue, in solution or powder form. Fentanyl is typically sold in very small quantities (micrograms or milligrams) as patches or powder, but several vendors who specialise in fentanyl products also offer quantities of 5–10 grams or more. Further monitoring of darknet markets could reveal niche markets that arise as larger omnibus markets become increasingly wary of the unwanted attention fentanyl invites from law enforcement agencies. During the course of this study, Empire and Berlusconi joined Dream Market in discouraging fentanyl listings.

On 16 April 2019, a transnational policing operation removed Wall Street, the major market for fentanyl, by arresting its German and Brazilian based operators (Europol 2019). The impact on the online availability of fentanyl may be short lived and displacement to other darknet markets is likely (Ladegaard 2019). In the post-Wall Street darknet 'universe' we observed a sharp decline in the availability of fentanyl, and only one of our selected markets, Tochka, continues to explicitly permit vendors to offer fentanyl and its derivatives. Some vendors displaced from Wall Street shifted operations to Empire or Berlusconi (or to other markets such as Nightmare and Agartha not included in this study). Although fentanyl listings appear to have been dispersed, many more fentanyl listings have subsequently been observed on Tochka.

## Conclusion

Darknet markets attract criminal entrepreneurs due to their efficiency and secrecy, and are proving to be near ideal platforms for the distribution of high-value, low-mass synthetic opioids. New synthetic opioids and other NPS redefine the traditional limits of high-value, low-volume or low-value, high-volume crime because small quantities of highly potent drugs can be posted or shipped across frontiers with a frequency that recalls the Chinese idiom 'ants moving houses'.

Novel ways to disrupt darknet operations and undermine the impunity of the criminals involved are needed. Proactive ‘fear, distrust and disruption’ activities are one means for law enforcement to suppress supply (Moeller, Munksgaard & Demant 2017). Undercover police operations or other means of disabling a market and arresting key players—as was the fate of Silk Road, AlphaBay, Hansa, Valhalla and Wall Street—can increase the perceived risk of arrest and help to reduce the scale of these illicit markets.

Perhaps unable to escape the uptake of synthetic opioids, Australia still has time to prepare and respond to the challenges of another dangerous drug. While public health and medical responses such as overdose reversal, addiction treatment, use of abuse-avoidant opioids and pain management are vital, so too will be a concerted effort to suppress supply and educate recreational drug users (Volkow & Collins 2017). Australia’s universal health care and emerging harm reduction responses may help reduce the risk of overdose fatalities (Larance et al. 2018). Costly implications for health services and high risks for drug users, coupled with a boost in the profits of criminal enterprises, are nevertheless likely.

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URLs correct as at November 2019

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